STATE OF MONTANA

Thomas L. Judge, Governor

BUREAU OF MINES AND GEOLOGY

S. L. Groff, Director

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December 1973

QUALITY AND RESERVES OF STRIPPABLE COAL, SELECTED DEPOSITS, SOUTHEASTERN MONTANA

by

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Montana Bureau of Mines and Geology

Analytical Data by

Laurence A. Wegelin

feet thick. These beds can be correlated with beds shown on a log of an oil well in the NW¼ sec. 12, T. 6 S., R. 42 E. (Pl. 33 and 34).

COAL QUALITY

Six core samples of the Knobloch coal bed were analyzed in the Montana Bureau of Mines and Geology analytical laboratory for proximate analysis, forms of sulfur, and heating value (Table 34), and major ash constituents (Table 35).

COAL RESERVES

All strippable reserves in the Poker Jim Creek-O'Dell Creek coal deposit are in the Knobloch coal bed (Table 33). The reserves total 938,070,000 tons, comprising 564,780,000 tons shown on Plate 11B and 373,290,000 tons shown on Plate 11A.

OTTER CREEK COAL DEPOSIT

LOCATION

The Otter Creek coal deposit (Pl. 12) is in T. 4 and 5 S., R. 45 and 46 E., about 12 miles south of Ashland by road. The deposit is limited on the west, south, and east by excessive overburden, and on the north it adjoins the Ashland (Pl. 13A and B) and the Poker Jim Creek-O'Dell Creek (Pl. 11A and B) coal deposits. To the southeast it borders the Diamond Butte (Pl. 19) and Goodspeed Butte (Pl. 20) coal deposits. It overlaps the Yager Butte (Pl. 23A and B) coal deposit to the east.

FIELD WORK AND MAP PREPARATION

The evaluation of strippable coal in the Otter Creek area was begun in 1967 when four holes were drilled on state-owned land (Matson, Dahl, and Blumer, 1968). In 1970 additional holes were drilled to extend the coal reserves and to gather data for structural control to accurately determine the strippable reserves. Gamma logs of several oil wells were helpful in developing the structural picture, as well as for compiling the overburden maps. The geology in the Otter Creek area was mapped during the summer of 1970 on black-and-white aerial photos and during the winter of 1972 on color aerial photos.

PREVIOUS GEOLOGIC WORK

The Otter Creek area was included in a report on the Birney-Broadus area (Warren, 1959); in a report on strippable coal (Ayler, Smith, and Deutman, 1969); and in a report on strippable coal deposits on state lands (Matson, Dahl, and Blumer, 1968).

LAND OWNERSHIP

The surface ownership in the Otter Creek area is divided between private individuals, the State of Montana, and the Federal Government. The State of Montana owns the surface in sec. 16 and 36 of each township, and the Federal Government has control of a few small tracts in the east half of T. 4 S., R. 45 E., and the land within the Custer National Forest. The rest of the surface is privately owned.

The ownership of the coal on state sections remains with the state; that on public lands with the Federal Government. The Otter Creek area is within the land grant to Burlington Northern, Inc., which owns coal on the odd-numbered sections outside the Custer National Forest. The railroad has conveyed most of the surface but has kept the coal rights from its original land grant. Some coal along the Otter Creek valley is privately owned.

SURFACE FEATURES AND LAND USE

The principal surface feature in the area, Otter Creek, is a northward-flowing tributary, which joins the Tongue River at Ashland. Except in unusually dry years, it contains water all year, but it also has periods of no flow each year. The major tributaries of Otter Creek flow only during periods of heavy precipitation and spring runoff. Tributaries entering Otter Creek from the east are long, have gentle gradients, and occupy wide valleys. They head near the top of the divide between Otter Creek and Pumpkin Creek to the east. Tributaries entering Otter Creek from the west are shorter and steeper. Otter Creek has deeply intrenched meanders; its present flood plain is about a half mile wide. Clinker formed by the burning of the underlying Knobloch coal bed borders the flood plain and forms nearly vertical clinker banks in places. A broad terrace, 100 to 150 feet above the present level of Otter Creek, has been deeply dissected in places by the tributaries of Otter Creek.

The principal land use in the area is livestock grazing, but grain and hay are raised in fields and meadows along Otter Creek and its tributaries.

GEOLOGIC STRUCTURE

Elevations obtained from drill data on the top of the Knobloch coal bed clearly show an anticline in the north half of T. 5 S., R. 45 E. At its crest, the strata have been uplifted about 80 feet above their position in the southernmost part of T. 4 S., R. 45 E., and in the northern part of T. 5 S., R. 45 E. The Knobloch bed is exposed about 30 to 40 feet above stream level near the crest of the anti-

Table 36.–Reserves, overburden, overburden ratio, acres, and tons/acre, Otter Creek coal deposit.

KNOBLOCH BED

Thickness of overburden, ft.	Indicated reserves, million tons	Overburden and interburden, million cu. yd.	Overburden ratio, cubic yards/ton	Acres	Tons/acre
0 to 50	241.77	275.52	1.13	3,686.4	65,591.4
50 to 100	492.21	953.30	1.93	7,091.2	69,413.3
100 to 150	535.42	1,582.42	2.95	7,352.6	72,820.5
150 to 200	487.51	1,454.34	2.98	4,870.4	100,104.7
200 to 250	318.64	1,141.97	3.58	2,790.4	114,207.9
Total	2,075.55	Total 5,407.55	Average 2.60	Total 25,791.0	Average 80,475.7

cline (Warren, 1959, p. 566). To the north in sec. 16, T. 4 S., R. 45 E., the Knobloch coal bed crops out near stream level, and to the south, in the south half of sec. 26, T. 5 S., R. 45 E., it dips below stream level. Although the information is inconclusive, because of scarcity of drill data, the changes in thickness of the Knobloch coal bed suggest that the anticline, as a structural feature, controlled to some extent the deposition of the Knobloch bed (Pl. 34, Section OC'-A'). The drill holes do show that the Knobloch bed thins and begins to split on the northern flank of the anticline, and the partings thicken on the southern flank, where the lowest bench of the Knobloch is either thin or missing.

COAL BEDS

The Knobloch coal bed contains the only strippable reserves in the Otter Creek coal deposit. Other coal beds include the King bed, which is 70 to 160 feet above the Knobloch bed in T. 5 S., R. 45 E., and several higher beds, which are exposed along the steep slopes of the ridges on both sides of Otter Creek.

The thickest coal section in the Otter Creek deposit was 66 feet as measured in drill hole SH-7054, sec. 2, T. 4 S., R. 45 E. Southward, the Knobloch bed thins gradually; in drill hole SS-6, sec. 16, T. 4 S., R. 45 E., it has a thickness of 47 feet. The split begins to develop in the Knobloch coal bed in the southern part of T. 4 S., R. 45 E., as shown in a log of an oil well in sec. 24 (Pl. 34, Section OC'-A'), where the upper bench is 46 feet thick and the lower bench is 19 feet thick. Both benches thin southward, as shown by the isopachs (Pl. 12). In the northern part of T. 5 S., R. 45 E., the upper bench of the Knobloch splits again and a bench called the middle bench appears. In about this same place, the lower bench thins and has not been traced farther south.

COAL QUALITY

Core samples from the Otter Creek coal field were analyzed by the Montana Bureau of Mines and Geology analytical laboratory, except for one sample taken in 1967 from drill hole SS-5, which was analyzed by the U.S. Bureau of Mines, Pittsburgh Coal Research Center.

Proximate analysis, forms of sulfur, and heating value are shown in Table 37, and major ash constituents are shown in Table 38.

COAL RESERVES

Strippable reserves in the Knobloch coal bed in the Otter Creek coal field total 2,075,550,000 tons (Table 36).

Table 37.–Proximate analysis, forms of sulfur, and heating value, Otter Creek coal deposit.

Drill hole and location	Depth sampled	Lab. number	Coal bed	Form of analysis 1/	Proximate, %				Form of sulfur, %				Heating value (Btu)
					Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Sulfate	Pyritic	Organic	
SH-7044			Knobloch	A	27.690	29.270	37.616	5.423	.157	.000	.008	.149	8515
5S R46E S30	178 to			B		40.479	52.021	7.500	.218	.000	.011	.206	11776
DDAD	187 ft.	233		C		43.761	56.239		.235	.000	.012	.223	12731
				A	28.470	30.685	36.001	4.844	.205	.000	.008	.197	8399
	187 to			B		42.898	50.330	6.772	.286	.000	.011	.275	11742
	197 ft.	234		C		46.014	53.986		.307	.000	.012	.295	12595
				A	28.940	28.224	38.987	3.849	.190	.000	.016	.175	8457
	197 to			B		39.719	54.864	5.417	.268	.000	.022	.246	11901
	199 ft.	235		C		41.993	58.007		.283	.000	.024	.260	12583
SH-7045			Knobloch	A	29.390	26.025	33.961	10.624	5.320	.126	4.295	.898	8011
5S R46E S20	60 to			B		36.857	48.097	15.046	7.534	.179	6.083	1.272	11345
CBBD	65 ft.	238		C		43.385	56.615		8.869	.210	7.161	1.498	13354
				A	36.400	25.739	33.990	3.871	.160	.021	.042	.097	7458
	106 to			B		40.471	53.443	6.086	.252	.033	.066	.153	11726
	115 ft.	229		C		43.094	56.906		.268	.035	.070	.163	12486
				A	29.790	28.268	36.774	5.167	.178	.023	.046	.108	7961
	115 to			B		40.263	52.378	7.360	.254	.033	.066	.154	11340
	124 ft.	230		C		43.461	56.539		.274	.036	.071	.167	12240
				A	24.560	30.464	40.739	4.237	.276	.025	.025	.226	8891
	124 to			B		40.382	54.002	5.617	.366	.033	.033	.300	11786
	127 ft.	231		C		42.785	57.215		.388	.035	.035	.318	12487
SH-7049			Knobloch	A	26.900	35.300	32.576	5.224	.225	.018	.045	.162	8261
5S R46E S2	177 to			B		48.290	44.563	7.146	.308	.025	.062	.221	11301
DCDB	185 ft.	246		C		52.007	47.993		.331	.026	.066	.238	12171
				A	29.580	29.938	35.761	4.721	.140	.000	.031	.109	8002
	185 to			B		42.514	50.783	6.703	.198	.000	.044	.154	11364
	193 ft.	247		C		45.568	54.432		.213	.000	.047	.165	12180
				A	31.350	30.795	34.151	3.704	.219	.000	.030	.189	7831
	193 to			B		44.858	49.747	5.395	.319	.000	.044	.275	11407
	197 ft.	248		C		47.416	52.584		.338	.000	.047	.291	12058
SH-7051			Knobloch	A	28.590	28.559	37.832	5.019	.181	.000	.000	.181	8305
4S R46E S33	116 to			B		39.993	52.979	7.028	.254	.000	.000	.254	11631
CBBA	126 ft.	250		C		43.016	56.984		.273	.000	.000	.273	12510
				A	30.850	26.986	38.550	3.614	.169	.000	.015	.154	8283
	126 to			B		39.026	55.748	5.226	.245	.000	.022	.222	11978
	135 ft.	251		C		41.178	58.822		.258	.000	.023	.235	12638
SH-7052			Knobloch	A	28.760	31.015	35.949	4.277	.277	.000	.016	.261	8258
5S R45E S27	106 to			B		43.535	50.461	6.003	.389	.000	.022	.367	11592
BDAC	116 ft.	253		C		46.316	53.684		.414	.000	.024	.390	12332
				A	31.730	36.569	28.188	3.512	.219	.000	.038	.181	8129
	116 to			B		53.566	41.289	5.145	.320	.000	.055	.265	11908
	126 ft.	254		C		56.471	43.529		.338	.000	.265	.279	12554
SH-7053			Knobloch	A	28.150	28.810	39.185	3.855	.143	.016	.016	.111	8576
4S R45E S4	112 to			B		40.097	54.537	5.365	.199	.022	.022	.155	11936
AAAA	122 ft.	255		C		42.371	57.629		.210	.023	.023	.163	12613

					Moisture								
SH-7053			Knobloch	A	28.530	30.904	36.817	3.748	.149	.016	.047	.086	8699
4S R45E S4	122 to			B		43.241	51.514	5.245	.208	.022	.066	.121	12171
AAAA	132 ft.	256		C		45.635	54.365		.220	.023	.069	.127	12845
				A	26.670	29.897	40.482	2.952	.129	.000	.016	.113	8812
	132 to			B		40.770	55.205	4.025	.175	.000	.022	.154	12017
	140 ft.	257		C		42.480	57.520		.183	.000	.023	.160	12521
				A	27.290	30.073	37.983	4.654	.166	.000	.047	.119	8823
	140 to			B		41.361	52.239	6.401	.228	.000	.065	.163	12134
	148 ft.	258		C		44.189	55.811		.244	.000	.070	.174	12964
				A	27.010	30.241	37.810	4.939	.152	.000	.040	.112	8694
	148 to			B		41.432	51.801	6.767	.208	.000	.055	.153	11912
	156 ft.	259		C		44.439	55.561		.223	.000	.059	.164	12776
				A	26.720	28.930	38.353	5.998	.175	.000	.024	.151	8543
	156 to			B		39.478	52.337	8.185	.239	.000	.033	.207	11659
	165 ft.	260		C		42.998	57.002		.260	.000	.036	.225	12698
				A	27.140	28.786	37.721	6.353	.388	.016	.024	.348	8496
	165 to			B		39.509	51.772	8.719	.533	.022	.033	.478	11661
	171 ft.	261		C		43.283	56.717		.584	.024	.037	.523	12774
SH-7054			Knobloch	A	25.490	30.717	39.261	4.532	.142	.025	.000	.117	8962
4S R45E S2	84 to			B		41.225	52.693	6.082	.191	.034	.000	.157	12028
DBDC	94 ft.	262		C		43.895	56.105		.203	.036	.000	.168	12807
				A	23.960	32.554	39.792	3.695	.168	.025	.000	.143	9314
	94 to			B		42.811	52.330	4.859	.221	.033	.000	.188	12249
	100 ft.	263		C		44.998	55.002		.233	.035	.000	.198	12875
				A	23.740	32.853	39.498	3.909	.149	.000	.017	.132	9301
	100 to			B		43.080	51.794	5.126	.195	.000	.022	.173	12197
	106 ft.	264		C		45.408	54.592		.206	.000	.023	.183	12856
SH-7055			Knobloch	A	26.320	29.855	37.444	6.381	.154	.000	.024	.130	8558
4S R45E S6	216 to			B		40.519	50.820	8.661	.209	.000	.033	.176	11615
DDBA	218 ft.	265		C		44.361	55.639		.229	.000	.036	.193	12717
SH-7060			Knobloch	A	29.190	29.104	37.372	4.334	.120	.000	.000	.120	8454
4S R46E S6	141 to			B		41.102	52.778	6.120	.169	.000	.000	.169	11939
DDAC	149 ft.	271		C		43.782	56.218		.180	.000	.000	.180	12717
				A	30.720	29.460	36.582	3.237	.126	.000	.024	.103	8373
	149 to			B		42.523	52.804	4.673	.182	.000	.034	.148	12086
	153 ft.	272		C		44.608	55.392		.191	.000	.036	.155	12678
SS-5			Knobloch	A	26.6	29.6	38.6	5.2	.200				8740
4S R45E S36	56 to			B		40.3	52.6	7.1	.300				11910
DADD	77 ft.	I-73319		C		43.4	56.6		.300				12810

[1]/A, as received; B, moisture free; C, moisture and ash free.

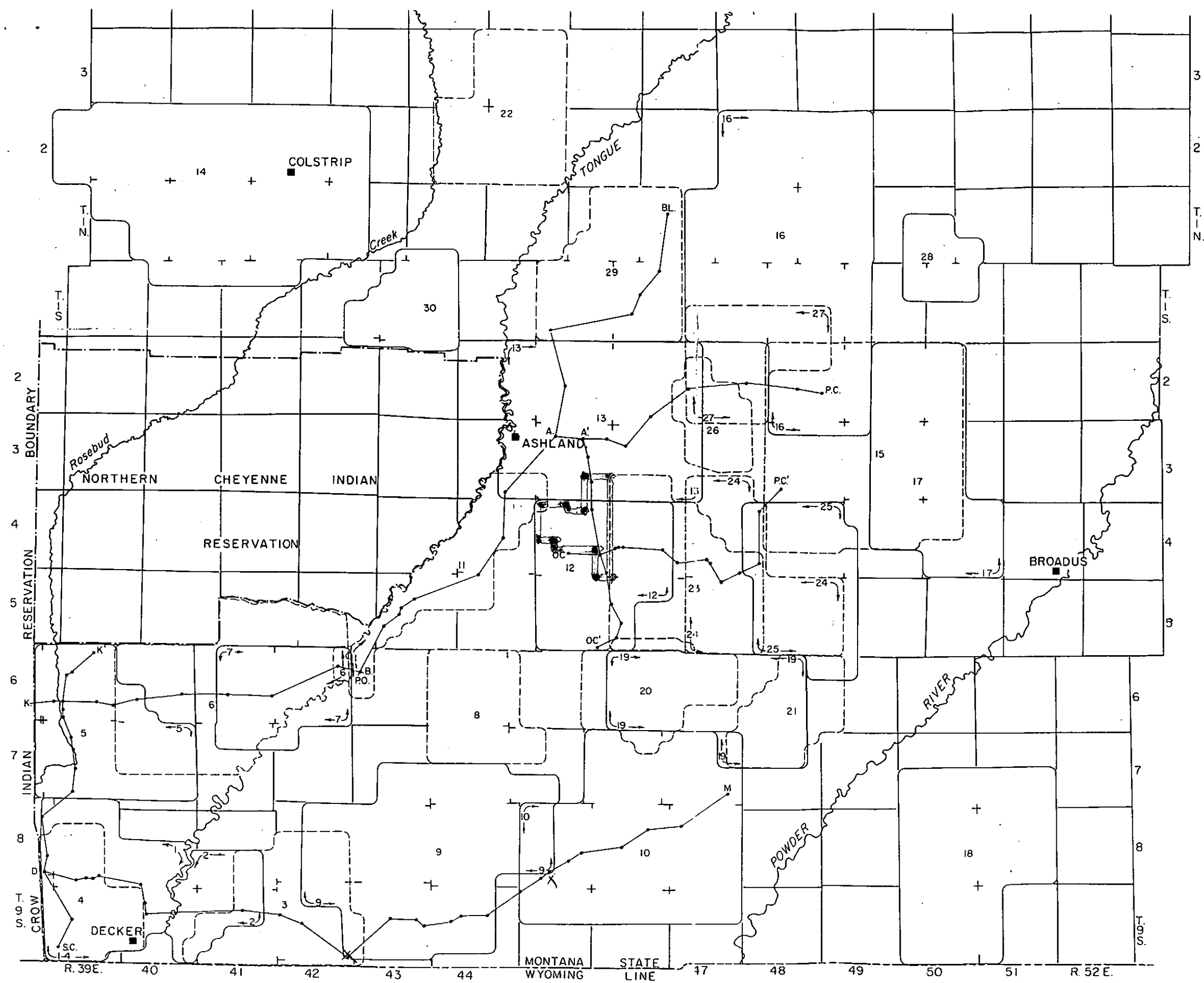
Table 38.–Major ash constituents, Otter Creek coal deposit.

Drill hole and location	Depth sampled	Lab. sample	Coal bed	Constituent, %										
				Al_2O_3	CaO	Fe_2O_3	K_2O	MgO	Na_2O	P_2O_5	SiO_2	SO_3	TiO_2	Total
SH-7044 5S 46E S30 DDAD	178 to 199 ft.	233-235	Knobloch	16.2	20.5	5.3	.5	3.5	7.5	.7	27.9	7.8	.6	90.5
SH-7045 5S 46E S20 CBBD	60 to 65 ft.	238	Knobloch	4.9	5.4	61.5	.5	.8	2.7	.1	11.0	10.3	.1	97.3
	106 to 127 ft.	229-231		12.4	20.4	4.9	.3	7.7	5.3	.5	32.2	10.5	.7	94.9
SH-7049 5S 46E S2 DCDB	177 to 197 ft.	246-248	Knobloch	16.4	23.8	5.0	.3	3.7	9.5	.2	28.6	8.3	.6	96.4
SH-7051 4S 46E S33 CBBA	116 to 135 ft.	250-251	Knobloch	18.1	24.1	5.0	.3	3.7	9.4	.7	30.3	7.2	.7	99.5
SH-7052 5S 45E S27 BDAC	106 to 126 ft.	253-254	Knobloch	18.1	20.1	4.7	.2	3.1	8.9	1.2	29.0	10.8	.6	96.7
SH-7053 4S 45E S4 AAAA	112 to 156 ft.	255-259	Knobloch	20.4	20.6	3.6	.2	3.9	9.4	.4	31.0	6.3	.8	96.6
	156 to 171 ft.	260-261		18.1	12.9	3.2	1.0	2.6	5.9	.2	42.2	9.5	.7	96.3
SH-7054 4S 45E S2 DBDC	84 to 106 ft.	262-264	Knobloch	21.5	24.5	3.4	.2	5.3	5.3	.2	25.7	7.1	.6	93.9
SH-7055 4S 45E S6 DDBA	216 to 218 ft.	265	Knobloch	22.0	15.0	2.7	.2	2.5	6.9	.7	39.8	4.9	.8	95.5
SH-7060 4S 46E S6 DDAC	141 to 153 ft.	271-272	Knobloch	19.6	22.5	3.8	.2	1.9	11.0	.1	30.2	5.9	.7	95.9

Table 1. Commonly mapped coal seams in the Montana portion of the Powder river Basin.

Roland
Smith
Anderson
Dietz
Canyon (Monarch)
Cook
Otter
Wall (Carney)
Pawnee
Brewster-Arnold
Sawyer
Knobloch
Nance
Rosebud
McKay
Flowers-Goodale
Terret
Robinson

(Matson, and others, 1973; Law and others, 1979)



INDEX TO AREAS SHOWN ON CORRESPONDINGLY NUMBERED PLATES AND TO LINES OF CROSS SECTIONS

N.P. No.7

Pan American No. 1

ROSEBUD CO.
POWDER RIVER CO.

T. 3 S.

East Home Creek

Willow Creek

SH-7062
3128'
57' at 3069'
T.D. 160'

SH-7063
3197'
58' at 3107'
T.D. 187'

Columbus Draw

Dillon Draw

Cherry Creek

Stafford

SH-7055
3231'
60' at 3030'
T.D. 251'

SH-7
3176'
60' at 3
T.D. 22

Threemile Creek

SH-7054
3104'
66' at 3021'
T.D. 180'

60' U.B.

55' U.B.

60' U.B.

Otter Creek

SS-6
3160'
47' at 3040'
T.D. 180'

SH-7060
3212'
61' at 3078'
T.D. 218'

BOUNDARY FOREST

Short Creek

55' U.B.

55' U.B.

T. 4 S.

50' U.B.

50' U.B.

0'

45' U.B.

0'

No.1-20 Atlantic
SH-7146

20' L.B.

Austin Gov. Nat.

Wolf Tap Creek

20' L.B.

SH-7145

I.P. No. 9

45' U.B.

SS-5
3264'
21' at 3208'
6' at 3150'
4' at 341'
T.D. -150'

20' U.B.

50'

10' L.B.

10' L.B.

15' M.B.

20' U.B.

31

50'

SH-7051
3348'
20' at 32

50'

25' U.B.

5 pdc

Tenmile Creek

6

Chroma Creek

50'

15' M.B.

Reserves not calculated

Otter Creek

Brian Creek

Chandler & Assoc. Inc.
Ten Mile - Gov. No. 1

10' M.B.

NATIONAL FOREST

SS-7
3288'
4' at 3190'
24' at 317
8' at 3140'
T.D. -170'

50'

25' U.B.

T. 5 S.

10' M.B.

Fifteenmile Creek

SH-7045
3289'
22' at 3184'
5' at 3057'
T.D. 280'

Creek

28 bbb

Pagel Creek

27 bdd

CUSTER FOREST

SH-7052
3244'
22' at 3139'
T.D. 250'

Creek

SH-7044
3279'
22' at 3102'
T.D. 290'

31

36

31

SS-8
3259'
2' at 3213'
21' at 3116'
T.D. -170'

QC'

R. 45 E.

R 46 E

Base map from U.S.G.S. 7 1/2 minute topographic maps:
King Min., Yoger Butte, Ft Howes, and Goodspeed Butte.

Project Chief - R. E. Matson
Geologist - J. W. Blume
Draftsman - E. A. W

MAP OF

OTTER CREEK COAL DEPOSIT

SHOWING

STRIPPABLE RESERVES IN THE KNOBLOCH COAL BED, POWDER RIVER COUNTY, MONTANA

MBMG Bulletin 91

SCALE

0 1/2 1 2 3 MILES

DATUM IS MEAN SEA LEVEL

EXPLANATION

——	Knobloch coal bed	•	M.B.M.G drill hole
	Clinker	SH-7044	hole designation
	0-50' of overburden	3279'	altitude at top of collar
	50'-100' " "	22' at 3102'	altitude at top of 22' of coal
	100'-150' " "	T D 290'	total depth of drill hole
	150'-200' " "	◇ Austin Gov. No. 1	Oil well drill hole
	200-250' " "	○ 28 bbb	Water well drill hole

QC' ——— Line of cross section (plate 34) ——— P.C.'

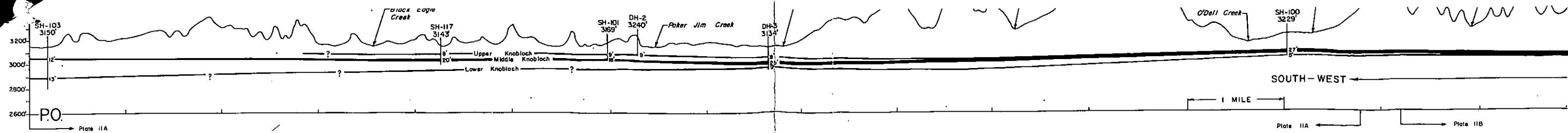
30'U.B. ——— Isopach of Upper or combined Benches

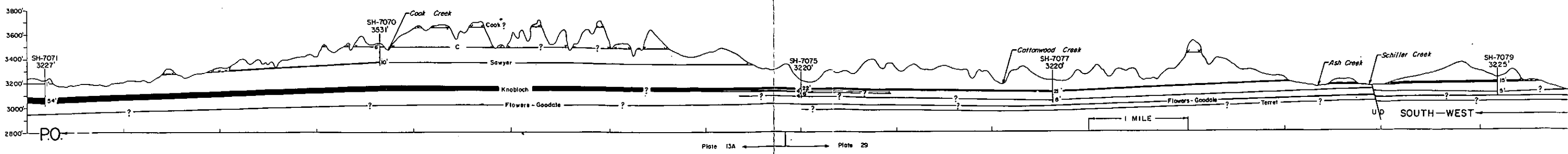
15'M.B. ——— Isopach of Middle Bench

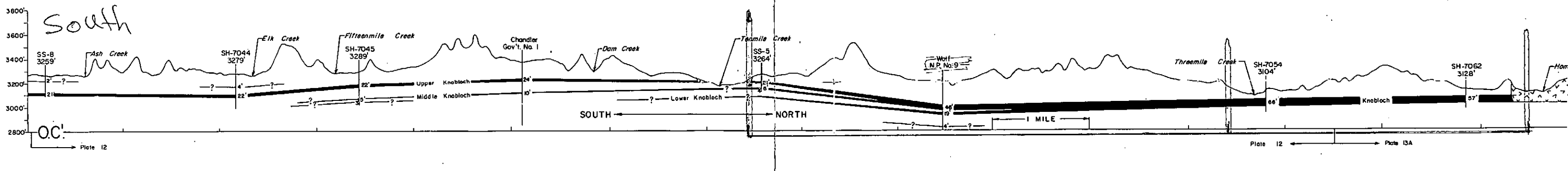
20'L.B. ——— Isopach of Lower Bench

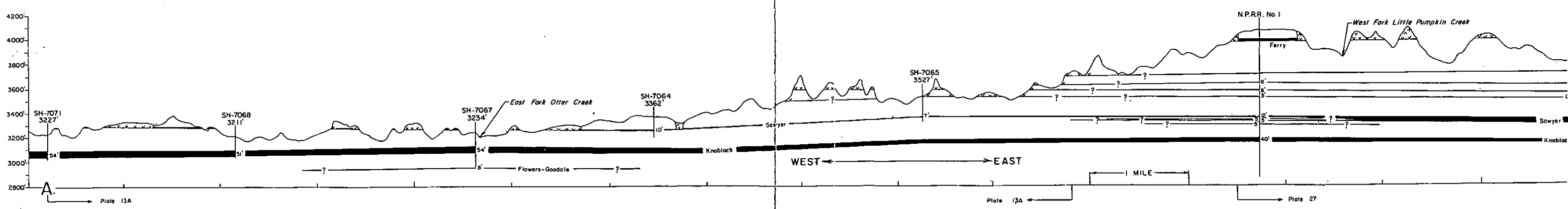
50' ——— Isopach of parting between Upper & Middle Benches

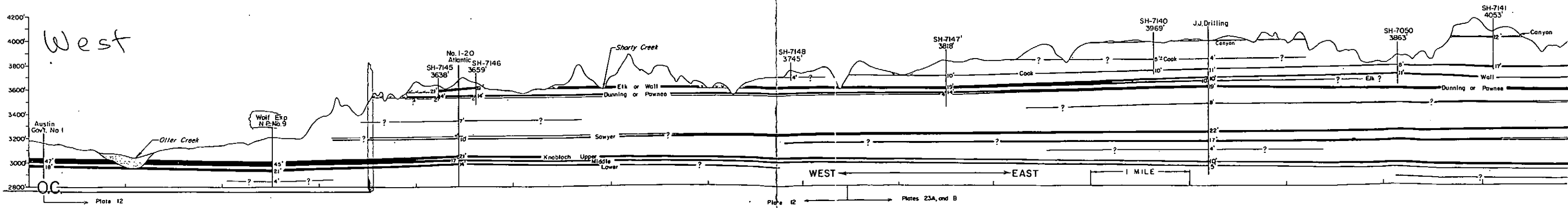
50' ——— Isopach of parting between Upper & Lower Benches











Vertical Exag. $\frac{2{,}000'}{300'} = 6\frac{2}{3}$ 300 ft. / 2,000 ft.

REGIONAL CROSS SECTIONS SHOWING STRUCTURE AN